

DISTRICT PRELIMINARY GEOTECHNICAL REPORT

San Diego Freeway (I-405) Improvement Project
SR-73 to I-605

Orange and Los Angeles Counties

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STATE OF CALIFORNIA
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December 17, 2010 (revised 08-25-11, 11-04-11, & 12-14-11)

Parsons Transportation Group, Inc.
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Attention: Jason Majzoub

Subject: **District Preliminary Geotechnical Report (DPGR)
I-405 Widening from SR-73 to I-605, Orange County, CA
2-ORA-405-PM 9.3/24.2, EA0H1000
GDC Project No. I-487**

Dear Jason:

We are pleased to submit our District Preliminary Geotechnical Report (DPGR) as part of the Project Report/ Environmental Document being developed by Parsons for widening of I-405 from SR-73 to I-605. This report was developed in general accordance with our Proposal No. I08-029 dated April 23, 2008. This report has been revised in response to Caltrans comments dated 2-17-11, 9-21-11, 11-18-11, and 12-12-11. The comments and our responses are included in Appendix B.

We appreciate the opportunity to assist you on this important project. Should you have any questions, please call us at (949) 450-2100.

Very truly yours,
GROUP DELTA CONSULTANTS, INC.

A handwritten signature in blue ink, reading "S. Ghanbari".



Shah Ghanbari, P.E.
President

A handwritten signature in blue ink, reading "Curt Scheyhing".



Curt Scheyhing, P.E., G.E.
Associate Geotechnical Engineer

Distribution: Addressee (3 Hard Copies and PDF file)

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**DISTRICT PRELIMINARY GEOTECHNICAL REPORT
I-405 FROM SR-73 TO I-605
12-ORA-405-PM 9.3/24.2, EA0H1000
ORANGE COUNTY, CALIFORNIA**

1.0 INTRODUCTION

1.1 Project Description

The California Department of Transportation (Caltrans), in cooperation with the Orange County Transportation Authority (OCTA), proposes to improve the freeway mainline and interchanges on Interstate 405 (I-405) in northern Orange County to reduce congestion and improve lane continuity through the corridor. Three build alternatives and a No Build Alternative are being considered for this project.

Alternative 1 proposes to add one general purpose lane in each direction of I-405 from Euclid Street to Interstate 605 (I-605) with some improvements on State Route 22 (SR-22). **Alternative 2** proposes to add the general purpose lane included in Alternative 1 and a second general purpose lane northbound from Brookhurst Street to the SR-22/7th Street interchange and southbound from Seal Beach Boulevard to Brookhurst Street. Alternative 2 would also include some improvements on SR-22. **Alternative 3** proposes to add the general purpose lane included in Alternative 1 and an additional median lane in each direction from State Route 73 (SR-73) to SR-22 East to operate together with the existing High Occupancy Vehicle (HOV) lanes as express lanes in which eligible HOVs would travel without a toll charge and other vehicles would pay a toll. Alternative 3 would include some improvements on SR-22, SR-73, and I-605.

The proposed improvements are generally within Orange County with minor improvements under Alternative 3 in Los Angeles County. Alternative 1 and Alternative 2 are carried forward from the Project Study Report/Project Development Support (PSR/PDS), approved in July 2008, which was the document prepared for the Project Initiation phase of the project. Alternative 3 was introduced at the beginning of the Project Approval/Environmental Document (PA/ED) phase. A project vicinity map is included in Figure 1, and a preliminary Layout Plan for Alternative 3 is presented in Figure 2 (sheets 1-48). Preliminary Layout Plans for Alternatives 1 and 2 are presented in Appendix C. A schematic drawing of the various alternatives is shown in Figures 3A and 3B.

In addition to the mainline lane widening, all of the build alternatives would include mainline geometric and interchange improvements as described below:



- Additional auxiliary lanes linking upstream on-ramps with downstream off-ramps at appropriate locations
- Providing standard left and right shoulders for the freeway and interchange ramps
- Reconfiguration of various interchange ramps and provision of increased ramp storage capacity
- Additional through and turn lanes at ramp intersections with local streets
- Improvements at nearby arterial street intersections affecting interchange operations
- Removal of HOV preferential lane from on-ramps to increase ramp storage capacity
- A new on-ramp from eastbound Euclid Street/Ellis Avenue to southbound I-405
- Reconfiguration of the Brookhurst Street interchange
- Braided ramps in both directions between Warner Avenue and Magnolia Street
- Reconfiguration of the Beach Boulevard interchange
- Reconfiguration of the Westminster Boulevard interchange

The proposed improvements would require 8 new structures (10 in Alternative 3), 17 overcrossing structure replacements (18 in Alternative 3) including 1 pedestrian bridge, and 5 structure widening/modifications (6 in Alternative 3) including 2 railroad overheads. Several existing flood control channels would be upgraded and 1 new storm drain bypass system would be added.

The project is expected to proceed to final design upon approval of the Final Project Report and a Record of Decision (ROD)/Notice of Determination (NOD) for the final environmental document. Construction of the project is anticipated to begin in 2015, with estimated completion date of 2020. For Alternative 3, a design-build project delivery method or a design-build-operate strategy may be utilized.

1.2 Purpose and Scope of Work

This report was prepared to provide preliminary geotechnical information for the PR/ED based on site reconnaissance and review of existing as-built plans and Log of Test Borings (LOTBs), published geologic and seismic data, aerial photographs, historical topographic maps, and other available information. For geotechnical purposes, we evaluated the most comprehensive improvements, Alternative 3.



Specifically, our scope of work included:

- Summarize anticipated site conditions and geology based on review of available topographic maps, aerial photographs, published regional geologic maps, liquefaction and landslide hazard maps, and our site reconnaissance;
- Review and summarize subsurface data and general subsurface conditions, including soil and groundwater conditions, based on existing as-built Log of Test Boring (LOTB) sheets (no borings were performed for this phase);
- Provide preliminary recommendations for geotechnical and seismic design parameters;
- Perform a preliminary evaluation of liquefaction potential along the alignment;
- Recommend likely types of foundation for earth retaining structures, soundwalls, and overhead sign structures;
- Provide comments on constructability, excavation, embankment, foundation bearing capacity, and slope stability;
- Discuss scope of work for final geotechnical investigation; and
- Prepare this report.

As-built foundation information, preliminary seismic recommendations, and preliminary foundation recommendations for proposed new bridges, bridge widening, and bridge replacement were provided in separate Structure Preliminary Geotechnical Reports (SPGRs) submitted along with the Type Selection packages. Environmental issues for the project were evaluated in a separate Initial Site Assessment (ISA) report.



2.0 EXISTING FACILITIES AND PROPOSED IMPROVEMENTS

The length of the project is approximately 16 miles. Project stationing along centerline of I-405 runs from south to north as follows:

- **Begin Project (SR-73):** Sta. 494+00 / Post Mile 9.3
- **End Project (I-605):** Sta. 1339+00 / Post Mile 24.2

The project vicinity is shown in Figure 1. Schematic lane layout is shown in Figures 3A and 3B. The Key Map and Layout Plans illustrating existing facilities and proposed improvements for Alternative 3 are shown in Figure 2 (sheets 1 through 48). Layout Plans for Alternatives 1 and 2 are presented in Appendix C.

2.1 Existing Facilities

The project passes through the cities of Costa Mesa, Fountain Valley, Huntington Beach, Westminster, Garden Grove, and Seal Beach, and crosses the major drainages of Santa Ana River and San Gabriel River (just north of the project). The area has extensive residential, commercial, and other development and contains numerous existing improvements, which are summarized in the following sections.

2.1.1 Bridges and Local Roadways

I-405 has existing bridge structures or culverts where it crosses drainages or local roadways. Existing bridges are generally supported on driven pile foundations. The locations of the existing bridges and drainage structures are summarized for reference in Table 1. In general, existing overcrossings will be replaced, undercrossings will be widened, culverts will be extended, and new structures will be constructed for ramps and other improvements.

2.1.2 Retaining Walls

Since the alignment area was originally flat with limited topographic relief, grade separations were created primarily by placing embankments with maximum heights of about 30 feet, with relatively few retaining structures. Locally tieback walls below abutments, concrete walls of moderate height, channel walls, and other wall types are present.



2.1.3 Pavements

Existing I-405 has one HOV lane in each direction for the full length of project and four to seven general-purpose lanes in each direction. An auxiliary lane is present between Magnolia/Warner and Beach/Edinger interchanges. Existing median shoulder, HOV, HOV buffer, mainline, and auxiliary lane pavements are primarily Portland Cement Concrete Pavement (PCCP), except between Harbor Blvd. and Beach Blvd., where all pavements are Asphalt Concrete (AC). Outside shoulders, ramps, and local roads are primarily Asphalt Concrete Pavement (ACP). Existing lane configuration is shown in Figures 3A and 3B. As-built pavement information is presented later in this report.

2.1.4 Drainage Structures

South and southwesterly flowing drainages cross I-405 at a number of locations. The more significant ones are listed in Table 1 and include:

- Greenville-Banning Channel (623+00, Post Mile 11.70);
- Santa Ana River (657+00, Post Mile 12.41);
- East Valley Channel (681+50, Post Mile 12.90);
- Ocean View Channel (791+50, Post Mile 15.00);
- Heil Avenue Drain (819+00, Post Mile 15.49);
- East Garden Grove Channel (839+50, Post Mile 15.87);
- Westminster Channel (943+50, Post Mile 17.80);
- Anaheim-Barber City Channel (1027+50, Post Mile 19.45);
- Bolsa Chica Ditch (1098+00, Post Mile 20.77);
- Los Alamitos Channel (1274+00, Post Mile 24.10); and
- San Gabriel River (1280+00).

Other minor drainage structures / culverts are also present.

2.1.5 Roadway Cut and Fill Slopes

Prior to the freeway construction the alignment area was relatively flat with limited topographic relief. No significant cut slopes are present. In general, most of the freeway is on shallow fill on the order of 5 feet above original grades; at selected locations the freeway is elevated up to about 25 to 30 feet above original grades (on



approaches to Harbor Blvd UC, Santa Ana River Bridge, Beach Boulevard (SR-39), Bolsa Overhead railroad crossing, and Navy Overhead railroad crossing). Approach embankments are present north and south of the freeway at all the overcrossings with heights on the order of 25 to 30 feet. Most fill slope inclinations vary between 2h:1v and 1.5h:1v.

2.1.6 Minor Structures

Numerous minor structures such as soundwalls and overhead signs are present along the alignment.

2.1.7 Surrounding Development

The surrounding area is fully developed, and includes residential, commercial, and municipal structures, schools, parks, military and other facilities.

2.2 Proposed Improvements

Figures 3A and 3B, respectively, show the northbound and southbound schematic of existing lanes and proposed lane additions for various alternatives. Figures 2-1 through 2-48 show the Key Map and Layout for Alternative 3. Layouts for Alternative 1 and 2 are presented in Appendix C. A summary of proposed retaining wall improvements based on Alternative 3 is included in Table 2. Anticipated improvements are summarized in the following sections.

2.2.1 Bridge Improvements

Bridge improvements will be performed and will need to be coordinated with the freeway, local roadway, and ramp modifications. Geotechnical information for bridges was provided in separate Structures Preliminary Geotechnical Reports (SPGRs).

2.2.2 Retaining Walls and Soundwalls

There are no natural slopes in the project area, and no permanent cuts are anticipated, so proposed retaining walls will generally retain new or existing fills. Where space is available embankment slopes will be used; where limited right of way is present, retaining walls will be built. Walls will be used for the following purposes:

- Mainline walls: to retain new embankment fills for the outboard sides of I-405 freeway and ramps; where the freeway is near original grades these walls are generally less than 10 feet in height; higher mainline walls up to about 18 feet



in height are proposed to retain the embankment widenings approaching existing railroad grade separations at Bolsa OH and Navy OH;

- Local roadway walls at Overcrossings: along the outsides of local roadways to retain new fill where existing Overcrossing approach embankments are widened and/or raised;
- New Structure Approaches: walls are proposed approaching new structures at 405/73 HOV Connector Separation, Euclid Street On Ramp Connectors, and Warner Ave On Ramp Connector Separation; and
- Cuts below existing abutments: To retain cuts into existing fills below abutments.

Current plans indicate most mainline and local roadway walls are planned as Standard Plan cast-in-place cantilever concrete walls (Type 1, Type 5, or similar). A tieback wall is proposed for widening of Beach Blvd. below Route 405/39 Separation. Mechanically Stabilized Embankment (MSE) Walls are proposed for approaches to some of the new bridge structures; MSE walls may also be considered as an alternative wall type to cast-in-place concrete walls. MSE walls are non-District items and are therefore not addressed in this report. Anticipated standard retaining wall improvements are summarized in Table 2.

Soundwalls, in general, may be based on the standard plans and supported on spread footings, CIDH piles, or trench footings. In absence of groundwater CIDH piles are normally the most economical; however, spread or trench footings may be more economical where shallow groundwater is present due to constructibility problems CIDH piles below groundwater. No information on soundwall locations or heights is currently available.

2.2.3 Fills and Cuts

No significant permanent cuts are anticipated. Fills will be placed to widen the freeway on the outside, to re-align ramps, and to widen existing abutment approaches to overcrossings and undercrossings.

2.2.4 Culverts

Placement of new outboard fills generally requires extension of existing channels and culverts.



2.2.5 Roadway Pavements

New pavements will mainly be required on the outboard sides of I-405, along ramp re-alignments, and for local streets. The new pavements will be Jointed Plain Concrete Pavement (JPCP) or Hot Mix Asphalt (HMA), and will be designed in accordance with the latest Caltrans Highway Design Manual, considering the actual tested R-Value of the site subgrade and the design traffic index. We anticipate that mainline pavement type will generally match the existing AC (HMA) or PCCP (JPCP), and that ramps and local roads will generally be HMA. Where expansive soils are encountered over-excavation of expansive soils below pavements will be required.

2.2.6 Overhead Signs

Overhead signs are anticipated as part of improvements. Foundations are generally Cast-in-Drilled-Hole (CIDH) piles using designs from Caltrans Standard Plans.



3.0 SITE AND SUBSURFACE CONDITIONS

3.1 Site Conditions

The site is located on an alluvial flatland. Based on review of the USGS Newport Beach, Seal Beach, and Los Alamitos 7.5-Minute Quadrangles, original grades along the alignment between SR-73 and Bolsa Chica Rd OC are in a narrow range between about El. +23 feet to +30 feet above Mean Sea Level. Between Bolsa Chica Rd OC and I-605, original grades drop from El. +23 feet to a low of about El. +10 feet at the north end of the project. The freeway road bed in most areas is on shallow fill on the order of 3 to 8 feet (+/-) above the original grade (El. +30 to +36 feet from SR-73 to Springdale, El. +26 at Bolsa Chica Road, El. +14 at Seal Beach Blvd.); on approaches to undercrossings (Harbor, Santa Ana River, Bolsa OH, Navy OH, Beach Blvd) the freeway is elevated on embankment up to about 30 feet high with top of embankment elevations of about El. +52 to +59 feet. Top of embankments at Overcrossings are generally 25 to 30 feet above the freeway level or El. +48 to +59 feet. Regional drainage is by sheet flow toward the south and west, and is collected in storm drains and generally southwesterly flowing channels. The area is extensively developed.

3.2 Subsurface Conditions

3.2.1 Geology and Seismicity

3.2.1.1 Geology

Regionally the project lies entirely within the Orange County flatlands of the southern portion of the Central Block of the Los Angeles Basin. The basin is infilled with up to 4,200 feet of relatively unconsolidated Pleistocene marine and non-marine sediments overlain by up to 170 feet of unconsolidated non-marine Quaternary and Holocene alluvial sediments. The depth of the unconsolidated sediments is generally shallowest near the south end of the project, becoming deeper towards the north.

The surface geology of the corridor is illustrated in the regional geologic map shown in Figure 4. The entire project alignment is underlain by young Holocene age alluvium (Qya) and alluvial fan deposits (Qyf) associated with the Santa Ana River and San Gabriel River systems. The alluvial materials are poorly consolidated and generally consist of interbedded layers of sands, silts, and clays. Near surface alluvium generally contains soft to stiff clays and silts, and loose to medium dense sandy soils. Loose / medium dense and soft / medium stiff materials are generally present in the upper 30 to 60 feet. Alluvial clays and silts generally become stiff to



very stiff, and sands become dense to very dense, at variable depth below the less consolidated surface sediments. Man-made fills associated with roadways and other developments have been placed over the alluvial soils. High historical groundwater is generally at a depth of 5 to 20 feet below the natural site grades (see Figure 5). The site is located in a liquefaction hazard zone (see Figure 6).

3.2.1.2 Seismicity

Major active faults in the project area based on Caltrans 2007 Fault Database are shown on the Caltrans ARS Online Fault Maps in Figures 7A and 7B. The regional tectonics of the area includes a number of sub-parallel northwest-southeast trending right lateral strike slip faults (Newport-Inglewood, Palos Verdes, and Whittier-Elsinore Fault Zones) that are part of the larger San Andreas Fault system, and a series of reverse and blind thrust faults (San Joaquin Hills Blind Thrust, Compton-Los Alamitos Blind Thrust, THUMS Huntington Beach, and Puente Hills Blind Thrust Faults). The closest major active faults are:

- The San Joaquin Hills Blind Thrust Fault (Maximum Magnitude 6.6, Reverse), which dips to the southwest below the southern portion of the project, with minimum depth of 2 km; the surface projection of the shallowest portion of the fault is located at a closest distance of about 0.6 km to the northeast;
- The Newport-Inglewood-Rose Canyon Fault Zone (Maximum Magnitude 7.5, Strike Slip), which is located at a variable distance of about 2 to 5 km southwest of the alignment;
- The Compton-Los Alamitos Blind Thrust Fault (Maximum Magnitude 6.8, Reverse), which dips to the northeast below the entire project alignment, with a minimum depth of 5 km; the surface projection of the shallowest portion of the fault is located at a variable horizontal distance of 7 to 10 km to the southwest of the site.

Seismic hazards including fault rupture hazard, ground shaking, and liquefaction are discussed in a later section of the report.

3.2.2 Subsurface Conditions

At the DPGR level only a paper study was performed based on existing available subsurface soil and groundwater data. As-built LOTBs for the existing bridges were reviewed for general information. We also obtained and reviewed available geotechnical reports from Caltrans Headquarters on District roadway items such as existing soundwalls (Wall Nos. 103, 151, 350, 271, 311, 131, 287, 350, 319, 328, 374, 375, 109, 435, 502, 583, 695, 741, 1098) and Retaining Walls (Wall Nos. 74,



205, 324, 166, 80, 84, 86, 18, 5011, 5050, 5650, 5770, 5790, 6150, 6310, 6345, 6950, 101, 102, and 100). As-built LOTBs for these roadway structures are presented in Appendix A.

Based on review of existing data, the approach fill embankments generally consist of compacted fill above native alluvial soils. The top of embankments generally ranges between about El. 50 and El. 60 feet. The original grade ranges between El. 25 and El. 30 feet. Native alluvial soils along the alignment generally consist of interbedded sands, sandy silts, silty sands, silts, clayey silts, and clays with occasional gravel. Alluvial clays are generally medium stiff to stiff and sands are loose to medium dense. Alluvium generally increases in stiffness / relative density with depth. Dense sands and very stiff clays are generally present below El. 0 to El. -40 feet along the alignment.

Recommendations for the scope of future site-specific explorations based on LRFD Guidelines are presented in Section 4.10 and must be performed during PS&E level design.

3.2.3 Groundwater

Our overall assessment of groundwater depth along the alignment considered groundwater levels from as-built LOTBs, as well as published data on the historically high groundwater (see Figure 5). The groundwater data from existing roadway borings (Appendix A), bridge LOTB, and historical high contours (Figure 5) are summarized in Table 3. The table also presents recommended high groundwater elevation based on the higher of the mapped levels or LOTB data.

In summary:

- The highest known groundwater is near El. +22 feet in the vicinity of SR-73 and Fairview Rd OC, or at a depth of 12 to 16 feet below the freeway grade;
- At Harbor Blvd, highest known groundwater is El. +13 feet or about 15 feet below Harbor Blvd;
- At Santa Ana River, highest known groundwater level is near El. +25 feet, or 3 feet above the channel bed elevation. This data is from 1964 and may represent higher levels prior to lining the channel with concrete;
- From Ward St to Springdale St, highest known groundwater levels are very consistent and range from El. +18 to +24 feet (average El. +21 ft), which is generally 8 to 13 feet below the lower of the existing freeway grade or the existing grade of the local roads / railroads crossing the alignment;



- Highest known groundwater level in the vicinity of Bolsa Chica Rd OC is near El. +16 feet, or about 10 to 14 feet below the freeway grade; and
- Highest known groundwater is near El. 0 feet at the north end of the project in the vicinity of Seal Beach Blvd and 605/405 Separation, or about 16 to 21 feet below the freeway level.



4.0 DISCUSSION AND PRELIMINARY RECOMMENDATIONS

4.1 Seismic Design Considerations

The site is located in a moderately active seismic area of Southern California, and ground shaking will be considered in the project design. A summary of seismic information is presented in Table 4.

4.1.1 Ground Surface Fault Rupture

The site is not located in an Alquist-Priolo Fault Zone and no faults considered capable of surface rupture are mapped as crossing the site or projecting towards the site in the geologic literature reviewed. The shallowest portion of the San Joaquin Hills Blind Thrust Fault underlies the southern portion of the alignment (see Figure 7B), but the fault depth is about 2km and not likely to rupture at the surface. Therefore, the potential for ground surface fault rupture in the project area is low.

4.1.2 Seismic Shaking

As of September 30, 2009 Caltrans has adopted new seismic design criteria (Appendix B of Caltrans SDC revised 8-12-09). A ground motion analysis was performed following the new Caltrans procedure using Caltrans ARS Online and spreadsheet tools. Our experience in the project area and as-built blowcount data indicates soils generally classify as Type D. For preliminary assessment, we assumed average shear wave velocity of 270 meters per second (average for soil type D). Final analyses should be performed in PS&E stage based on site-specific shear wave velocity measurement. The upper bound envelope of deterministic and probabilistic (5% probability of exceedence in 50 years or 975 year average return period) was developed. USGS 2008 deaggregation (Beta) was used for probabilistic assessment since it is higher than ARS online. The site is located in a deep sedimentary basin, and appropriate basin effect was included. Hanging wall and near-source factors were also applied as appropriate. A summary of the seismic analyses are presented in Table 4. Based on the results, we conclude the following:

- Deterministic analyses rather than 975-year probabilistic analyses control the PGA values for the entire project alignment;
- Estimated Peak Ground Acceleration (PGA) for the entire alignment ranges from 0.51 to 0.60g's;
- The calculated PGA is controlled by:
 - San Joaquin Hills Blind Thrust Fault for the portion of alignment from SR-73 to Bushard Street;



- The Compton-Los Alamitos Blind Thrust Fault for the portion of alignment from Bushard Street to 405/605 Separation.

The seismic results should be considered a good preliminary estimate but may be subject to change in the final PS&E investigation. Details of the ground motion evaluations for each bridge were provided in the separate Structures Preliminary Geotechnical Reports (SPGRs) as part of the Advance Planning Study (APS) submittals.

4.1.3 Liquefaction Potential

The site is in a State of California mapped Liquefaction Hazard Zone (Figure 6), has relatively shallow groundwater, layers of loose to medium dense saturated granular soils, and moderate to high earthquake accelerations. Therefore, liquefaction potential should be considered high.

Existing as-built data is not adequate to provide good quantitative estimates of the hazard. ***The actual hazard should be expected to vary at different locations within the site, and could range from negligible to significant.*** For example, in the West County Connectors Project at the SR-22 / I-405 interchange liquefaction was isolated to occasional thin layers and no significant mitigation was required.

Quantitative liquefaction assessment, potential impacts, and mitigation measures for each embankment, retaining wall, sign foundation, and other roadway structure should be addressed in the PS&E level geotechnical investigation. Depending on the groundwater levels and the actual density, depth, layer thickness, fines content, plasticity, and post-liquefaction strength of potentially liquefiable soils, these impacts may include ground settlement, reduced foundation bearing capacity, and/or seismic slope instability.

The peak ground accelerations listed in Table 4 and a magnitude of 7 would be appropriate for preliminary liquefaction analysis. If results of site-specific investigation indicate high potential for seismic slope instability or lateral spreading, additional mitigation such as soil improvement / ground modifications could be required.

4.1.4 Seismic-Induced Landslides

There are no natural slopes in the project area, and the site is not in a mapped landslide hazard zone. Potential for seismic induced slope failures in the project area would be limited lateral spreading of fill embankments due to ground shaking



combined with presence of soft soils and/or loss of soil shear strength due to liquefaction.

4.2 Retaining Walls

Selection of earth retaining system types should be based on consideration of foundation bearing capacity, anticipated settlement and ability of the system to tolerate settlements, overall slope stability, constructability, and cost. Currently cast-in-place concrete walls, tieback walls, and Mechanically Stabilized Embankment (MSE) walls are anticipated. Only District Standard Plan retaining walls are addressed in this report. A preliminary list of anticipated cast-in-place retaining walls for freeway and local road widening is presented in Table 2.

4.2.1 Cast-in-Place Concrete Walls

Caltrans Standard Type 1 through Type 6 walls (as shown in Sheets B3-1 through B3-11 of the 2006 Caltrans Standard Plans) and similar concrete walls including barriers or soundwalls and Type 7 walls (as shown in the Bridge Standard Details "xs14" series sheets) are considered feasible for applications in the project area, but the bearing capacity will be limited when footings are in close proximity to the alluvial soils and groundwater table. As shown in Table 2, planned cast-in-place (CIP) wall heights are expected to range from 4 feet up to about 24 feet. CIP walls higher than about 10 ft design height with footing elevations in native alluvium (below about El. +30 feet) in many areas will not have adequate bearing capacity for spread footings and may need to be supported on piles, or consider other options such as MSE walls or walls with lightweight cellular concrete backfill.

In general, the bearing capacity of a cast-in-place concrete wall footing is controlled by the soils within about 1 footing width below the bottom of the footing. Original grade elevations and groundwater elevations are listed in Table 3. Soils below the original grades (about El. +30 feet) are alluvium; portions above the groundwater table (between about El. +30 and +23 feet) may be stiff near the surface, becoming soft near and below the groundwater table. Near surface alluvial soils in most areas are soft and in their current state have inadequate bearing capacity, especially for the higher walls, and especially when close to the groundwater table.

Properly compacted granular fills are likely to have adequate bearing capacity. The foundation bearing capacity and feasibility of each cast-in-place wall on spread footings will depend on wall height, footing elevation, local soil and groundwater conditions, total/differential settlements, and remedial grading below the foundation; this will need to be confirmed by site specific foundation investigation and



recommendations for each wall in the PS&E studies. For cost estimation purposes, the following are recommended for cast-in-place concrete walls:

Bottom of Footing Elevation (feet)	Design Wall Height (feet)	Foundation Type	Subgrade or Remedial Grading Requirement
< +26		CIP Wall Foundations with bottom of footing below El. +26 or very close to groundwater and soft soils should be avoided, if possible.	
+26-30	Up to 10	Spread Footing	Overexcavate 3 feet and Replace (OX&R) with Structural Backfill (SBF), may require subgrade stabilization at bottom of OX since near groundwater
	>10	50' Long Class 90 Piles	None
+30-35	Up to 14	Spread Footing	OX&R and/or new engineered fill to provide minimum 5 feet of SBF below footing, may require subgrade stabilization at bottom of OX since near groundwater
	>14	55' Long Class 90 Piles	None
+35-40	Up to 18	Spread Footing	OX&R and/or new engineered fill to provide minimum 6 feet of SBF below footing
	>18	50' Long Class 90 Piles	None
>+40	Up to 24	Spread Footing	Minimum 10 feet new embankment (SBF) or Minimum 10 feet of existing competent compacted embankment (assume minimum 2 feet OX & recompact in existing embankment)

Where liquefaction settlement or settlement from placing embankment is too large, pile supported retaining walls may not be appropriate. Lightweight cellular concrete backfill or more flexible Mechanically Stabilized Embankment (MSE) walls, which have lower applied bearing pressures and are more tolerant of settlement, may be more appropriate.

4.2.2 Lightweight Fills

Where foundation settlements are excessive, bearing capacity is inadequate, and ground improvements are not economical, consideration may be given to use of lightweight backfill behind retaining walls. This type of backfill may consist of lightweight aggregates or cellular concrete, and may be used behind cast-in-place facing (similar to cast-in-place walls).



4.3 Culverts

A number of box culverts cross the alignment and will need to be extended for the outboard widening of I-405. Separate SPGRs were prepared for extension of culverts at the Service Road Undercrossing just east of Santa Ana River, and at the Greenville-Banning Channel located between Harbor Blvd and Santa Ana River. The East Garden Grove-Wintersburg Channel will not be extended, but will have bridges spanning the channel; these bridges were addressed in a separate SPGR. For Wintersburg Channel, on the downstream side, a pier wall (18' in length) will be added in the channel. On the upstream side the new pier wall will be inside the RCB headwall so no channel encroachment is required.

Additional culvert extensions not addressed in SPGRs include East Valley Channel, Ocean View Channel, and Heil Avenue Drain. Culverts in the project area are generally supported on concrete slabs. The following general guidelines can be used for the design of extension of the culverts:

- Field data indicate that the foundation soils at the base of the culverts are generally at or near the water table, and in general, consist of loose to medium dense granular soils and soft to stiff clay and silt;
- We recommend that to provide uniform support, the upper 2 ft of soils below the bottom of the slab be excavated and replaced with granular soils compacted to 95% relative compaction. These compacted soils will have adequate bearing capacity to support the culverts;
- In some areas, groundwater and/or unsuitable soils may be encountered at the excavation subgrade level. If groundwater and/or loose, soft, wet soils, or otherwise unstable subgrade is encountered at the bottom of the excavation, dewatering and/or overexcavation and replacement with biaxial geogrid (Tensar BX 1100 or equivalent) and 1 to 2 feet of crushed rock may be used to stabilize the base prior to backfilling;
- Culverts should be designed to support the weight of the overburden and traffic surcharge. The overburden pressure on the box culvert can be calculated by multiplying the unit weight of the soil cover by the thickness of this cover. For design purposes, a soil unit weight of 135 pcf may be used;
- Caltrans Standard Plans and Section 19 of Caltrans Standard Specifications should be followed in the preparation of foundation soils, bedding, and backfill for the placement of culvert;
- Corrosion characteristics of the site soils and abrasion characteristics of the flow should be considered in accordance with the Highway Design Manual;



- Settlements due to placement of the weight of culvert and backfill should be anticipated. The magnitude of the settlement will depend on the local soil conditions and the weight of the culvert and depth of overlying backfill; some differential settlement could occur between the new extension and the existing culvert;
- Due to presence of saturated clayey layers some long-term consolidation settlement may occur; the actual time required for settlement to take place will be determined based on actual embankment geometry, soil types and consolidation properties, layer thickness, and single versus double drainage conditions; and
- If determined necessary based on the final investigation, the effects of the settlement may be mitigated by: 1) preloading the culvert extension, waiting for the settlement to be completed, then excavating and constructing the culvert extension; 2) use of lightweight backfill on top of the box, or 3) supporting on piles.

4.4 Construction Considerations

4.4.1 Rippability

Existing alluvial soils and fills in the project area may be excavated with moderate effort using conventional heavy duty grading equipment. No soils or rock requiring blasting or heavy ripping are known to exist in the project area.

4.4.2 Excavation, Groundwater, Soft Soils, and Dewatering

Groundwater levels along the alignment may be estimated from Table 3, and are generally within 10 feet of the lowest site elevations. In general, soils close to the groundwater are soft materials. Excavations extending close to El. +20 feet in most areas of the alignment are likely to encounter soft soils and the permanent groundwater table. Deeper open excavations will require dewatering. Depending on locations, drilled piles (for sign foundations or soundwalls) may extend below the groundwater and will require appropriate construction methods.

4.4.3 Site Preparation

In general, earthwork should be performed in accordance with Sections 6 and 19 of the Caltrans Standard Specifications. The new construction will have to be carefully planned to protect the many existing utilities in the area.



All areas to receive fill should be stripped of existing pavements, cleared of any structures, all existing vegetation, debris, and other unsuitable materials in accordance with Section 16 of Caltrans Standard Specifications. All construction debris and/or deleterious material encountered during the clearing operations should be removed from the site. After clearing and stripping, the surface should be excavated to a minimum of 2 feet before placement of new fill. Overexcavation may be waived by the geotechnical engineer if competent soils are present at the foundation level. The exposed surface should be proof-rolled with loaded heavy equipment. Any areas of loose or yielding soils should be overexcavated and recompacted. If soft materials are encountered near the water table and further removals are impractical, the bottom may be stabilized using biaxial geogrid (such as Tensar BX1200) and 12 to 24 inches of crushed rock. Any soils which cannot be compacted or are otherwise unsuitable for the planned use should be removed and disposed of offsite. The exposed surface should then be scarified and compacted to the specified density before placement of new fill.

4.4.4 Subgrade and Foundation Treatment

All compaction testing should be performed in accordance with Caltrans Test Method 216. A minimum relative compaction of 95% must be obtained for the subgrade soils to a minimum depth of 6 inches below the grading plane for the width between the outer edges of shoulders, whether in fill or in excavation. In addition, for the width of the traveled way plus a distance of 3 feet horizontally beyond, the subgrade materials to a depth of 2.5 feet below the finished grade should also be compacted to at least 95% relative compaction, whether in embankment or excavation.

Where poor near surface soil conditions exist, some remedial grading (removal and recompaction) will be required below cast-in-place wall foundations if walls are to be supported on spread footings, or below MSE walls. For planning purposes, the remedial grading recommended in Section 4.3.1 and 4.3.2 should be assumed for the alluvial areas. Where overexcavation will extend to near the water table, limited dewatering and stabilization with geogrid and crushed rock may be required prior to backfilling the overexcavation.

All new embankment (including replacement of unsuitable soils) supporting retaining walls within a zone defined by 1:1.5 planes extending down and out from lines 1 foot outside the edge of footing should be placed at a relative compaction of not less than 95 percent (Caltrans Standard Specification 19-5.03 and Standard Special Provision SSP 19-600).



4.4.5 Structural Backfill Behind Walls

All backfill placed behind retaining walls should be granular structural backfill compacted to a minimum of 95% relative compaction in accordance with Section 19-3.06 of Caltrans Standard Specifications. An additional specification is that no material greater than 3 inches should be used as structural backfill. Operation of heavy compaction equipment adjacent to walls can cause excessive lateral soil pressures to develop on the wall. For this reason, it is recommended that all fill placed within 3 feet of the walls should be compacted with hand-operated equipment.

4.4.6 Temporary Excavation and Shoring

Temporary shoring may be required for footing or wall excavations or other purposes. During construction, the maintenance of safe and stable slope angles and shoring is the responsibility of the contractor, and should consider the actual subsurface conditions encountered and the contractor's method of operation. Existing improvements should be protected. Temporary excavations should be shored, or in lieu of shoring, sloped at 1:1 (H:V) or flatter. Caving and sloughing can be anticipated for steep excavations. All shoring should be performed following applicable OSHA guidelines and Caltrans Trenching and Shoring Manual.

4.5 New Fills

4.5.1 Slope Stability

Static and seismic stability of fill slopes should be evaluated. Fill slopes should generally be limited to 2h:1v inclination; paved slopes below abutments should be limited to a maximum 1.5h:1v inclination. Most slopes are anticipated to be globally stable under static conditions. Seismic slope instability may occur where liquefiable or soft soils underlie embankment slopes; most of the site has soft and/or potentially liquefiable soils below embankments. This should be evaluated quantitatively and mitigated as necessary in the final design.

4.5.2 Settlement

Magnitude and time rate of settlement will be an issue where embankments are placed, since most of the site contains significant thickness of near surface soft alluvial soils. Due to thick layers of soft clays in many areas, where substantial fills are placed significant settlement should be anticipated, and long term consolidation should be anticipated. The settlement magnitude of time rate will depend on the



amount of fill placed and the local soil conditions. This should be evaluated quantitatively and mitigated as necessary in the final design.

4.5.3 Recommendations for Imported Fills

Any imported borrow materials used for embankment should have an R-Value of at least 40 (top 4 feet from finished grade) and be non-corrosive, low expansion and free of other deleterious properties that adversely affect all concrete/steel structures. The imported borrow shall conform to Section 19-7.02 of Caltrans Standard Specifications (May 2006) and be tested prior to placement.

4.6 Approach Slabs

Approach slabs are required to minimize the effect of any long-term settlement in the approach area, including seismically-induced movements. The type of approach should be selected in accordance with Section 5.3 of Caltrans Memo to Designers. Approach slabs should be designed in accordance with Caltrans Highway Design Manual which includes provisions for drainage behind abutments.

4.7 Corrosion Potential

In the West County Connectors Project near SR-22 interchange, soils were determined to be corrosive due to high chlorides and sulfates. Corrosive conditions are likely to be present in the remainder of the alignment. Corrosion mitigation for steel and concrete structures should generally follow Caltrans Corrosion Guidelines (2003 or latest). The latest Caltrans Highway Design Manual (Section 855) provides corrosion requirements for roadway structures (culverts, signs, etc) for a 50-yr design life (Caltrans, 2010).

The project engineer shall request for a Materials Report in the early stage of PS&E. The report shall include the results of field tests and sampling for Corrosion (pH, Sulfate, Chloride, and Minimum Resistivity) for use in recommending culvert materials and concrete mix designs. Sampling and testing shall be performed in accordance with Caltrans Corrosion Guidelines (2003 or latest).

4.8 Scour Potential

Most or all of the channels crossing the alignment are paved or lined with rip rap. Any unlined channels should be evaluated for scour and the scour depth considered in the foundation design.



4.9 Additional Field Exploration and Laboratory Testing

During PS&E stage subsurface conditions for the geo-structures (i.e. embankment fill, slopes, cut sections, etc.), bridge structures, and structures addressed in the GDR (sign structures, sound walls, etc.), must be based on site specific explorations following the latest LRFD guidelines. The results of the PS&E geotechnical investigations will be presented in separate reports as follows:

- **Geotechnical Design Report (GDR)** for general project grading, cuts, fills, and standard earth retaining systems, sound walls, standard signs, and conventional culverts;
- **Preliminary Foundation Report (PFR)** for type selection of each bridge structure and special design wall;
- **Foundation Reports (FRs)** for each bridge structure and special design wall, signs, culverts, or other structures;
- **Materials Report (MR):** A Materials Report for the alignment is required for Corrosion, culvert material selection, and Structural Sections recommendations.

The roadway and pavement investigations should address the potential impacts of expansive soils on the roadway, and recommend appropriate remediation measures, as necessary.

Additional studies may include Aerially Deposited Lead (ADL) or other environmental investigations.

An adequate number of borings and CPTs should be performed and should be advanced to sufficient depth to meet Caltrans LRFD requirements as outlined in the latest versions of:

- AASHTO LRFD Bridge Design Specifications with Caltrans Amendments;
- Caltrans Bridge Design Specifications;
- Caltrans Guidelines for Structures Foundation Reports;
- Caltrans Foundation Report Preparation for Bridge Foundations;
- Caltrans Guidelines for Preparing Geotechnical Design Reports; and
- Caltrans Geotechnical Manual.



Specific requirements for minimum number of exploration points, location of exploration points, and depth of explorations should follow Section 10.4.2 and Table 10.4.2-1 of the LRFD guidelines.



5.0 LIMITATIONS

The report is based on our review of limited existing structural, geotechnical and seismic data for the site. Our recommendations and evaluations were performed using generally accepted engineering approaches and principles available at this time, and the degree of care and skill ordinarily exercised under similar circumstances by reputable geotechnical engineers practicing in this area. No other representation, either expressed or implied, is included in our report.



6.0 REFERENCES

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TABLES

**TABLE 1
SUMMARY OF EXISTING BRIDGE LOCATIONS**

Postmile	Bridge Number	OU ¹	Structure Name or Route Information	City ²	Bridge Length (feet)	Bridge Width (feet)	Number of Spans	Year Built	Year Ext/Wid	Year EQ Retrofit
_010.28	55-0434G	O / U	N73-N405 CONNECTOR OC	CMS	520	53	4	1968	-	-
_010.29	-	-	JCT RTE 73	CMS	-	-	-	-	-	-
_010.35	55-0435F	O / U	S405-S73 CONNECTOR OC	CMS	348	53	4	1968	-	-
_010.79	55-0432	U	FAIRVIEW ROAD OC	CMS	291	125	4	1968	1989	-
_011.45	55-0257	O	HARBOR BLVD UC	CMS	204	223	4	1966	1988	-
_011.70	55-0476	O	GREENVILLE-BANNING CHANN	CMS	39	-	3	1966	-	-
_012.40	55-0259	O	SERVICE ROAD UC	CMS	21	-	1	1966	2001	-
_012.41	55-0258	O	SANTA ANA RIVER	CMS	440	204	6	1966	2001	-
_012.90	55-0477	O	EAST VALLEY CHANNEL	FNV	22	-	2	1966	-	-
_013.15	55-0429	U	WARD STREET OC	FNV	252	37	4	1966	-	1996
_013.41	55-0260	U	TALBERT AVENUE OC	FNV	421	61	4	1966	-	1995
_013.78	55-0402	U	BROOKHURST STREET OC	FNV	447	120	4	1966	-	1995
_014.13	55-0261	U	SLATER AVENUE OC	FNV	316	64	4	1966	-	-
_014.50	55-0262	U	BUSHARD STREET OC	FNV	302	61	4	1966	-	-
_014.82	55-0263	U	WARNER AVENUE OC	FNV	422	111	5	1966	1998	1995
_015.00	55-0478	O	OCEAN VIEW CHANNEL	FNV	41	-	2	1966	-	-
_015.21	55-0264	U	MAGNOLIA STREET OC	HNTB	430	61	4	1966	-	1995
_015.48	55-0407	U	HEIL AVENUE POC	HNTB	614	10	7	1966	-	-
_015.49	55-0479	O	HEIL AVENUE DRAIN	HNTB	23	-	3	1966	-	-
_015.87	55-0480	O	EAST GARDEN GROVE CHANNEL	WTM	34	-	3	1966	-	-
_015.90	55-0265	U	NEWLAND STREET OC	HNTB	280	37	4	1966	-	1995
_016.28	55-0266	U	EDINGER AVENUE OC	HNTB	422	61	4	1966	-	1995
_016.52	55-0267	O	ROUTE 405/39 SEPARATION	HNTB	268	234	4	1965	1989	-
_016.54	-	-	JCT RTE 39	HNTB	-	-	-	-	-	-
_016.98	55-0268	U	MCFADDEN AVENUE OC	HNTB	359	40	4	1965	-	1995
_017.21	55-0269	O	BOLSA OVERHEAD	WTM	183	155	3	1965	1989	1996
_017.75	55-0270	U	BOLSA AVENUE OC	WTM	427	82	4	1965	-	-
_017.80	55-0462	O	WESTMINSTER CHANNEL	WTM	25	-	2	1965	-	-
_017.94	55-0271	U	GOLDEN WEST STREET OC	WTM	414	82	4	1965	-	-
_018.36	55-0272	O	NAVY OVERHEAD	WTM	177	155	3	1965	1989	1996
_018.60	55-0273	U	EDWARDS STREET OC	WTM	299	72	4	1965	1988	-
_019.16	55-0274	U	WESTMINSTER AVENUE OC	WTM	403	108	4	1965	-	-
_019.38	55-0275	U	SPRINGDALE STREET OC	WTM	378	64	4	1965	-	-
_019.45	55-0461	O	ANAHEIM-BARBER CITY CHANNEL	WTM	42	-	4	1965	-	-
_020.56	55-0276	U	BOLSA CHICA ROAD OC	WTM	255	83	4	1965	-	-
_020.66	55-1103F ³	O / U	405-22 HOV CONNECTOR SEPARATION	WTM	1,110	59	5	2010-?		
_020.74	-	-	JCT RTE 22 EB	GGR	-	-	-	-	-	-
_020.75	55-0331F	O / U	S405-E22 CONNECTOR OC	SLB	586	52	4	1965	-	-
_020.75	55-1101F ^{3,4}	O / U	S405-E22 CONNECTOR SEPARATION	SLB	759	59	3	2010-?		
_020.77	55-0334	O	BOLSA CHICA DITCH	SLB	38	-	3	1959	1965	-
_022.64	55-0365	U	SEAL BEACH BLVD OC	SLB	450	75	4	1965	1972	-
_023.27	-	-	JCT RTE 22 WB	SLB	-	-	-	-	-	-
_023.28	55-0333G	O / U	N405-W22 CONNECTOR OC	SLB	461	40	4	1965	-	-
_023.98	55-0412G	U	E22-N405/405 CONNECTOR SEPARATION	SLB	357	26	4	1966	-	-
_024.02	55-0412R	U	605/405 SEPARATION	SLB	436	41	4	1966	-	-
_024.04	55-0412L	U	605/405 SEPARATION	SLB	317	72	4	1966	-	-
_024.05	-	-	JCT RTE 605	SLB	-	-	-	-	-	-

NOTES:

1. OU: O=Freeway is "on" the structure, U=Freeway crosses "under" the structure
2. Cities: CMS=Costa Mesa, FNV=Fountain Valley, HNTB=Huntington Beach, WTM=Westminster, GGR=Garden Grove, SLB=Seal Beach
3. New structure being constructed as part of SR-22 improvements
4. Replaces Bridge No. 55-0331F.

I-405 Mainline



GROUP
DELTA
CONSULTANTS

TABLE 2
SUMMARY OF PROPOSED RETAINING WALLS

Location	Alignment Section	Purpose	Approx. Station	Side	Prelim. Wall Type	Height (feet)	
						from	to
Local Streets	Ward St	widen road and approach fill	15+50 to 20+07	NB, Right	Type 1	4	16
			19+30 to 20+47	SB, Left	Type 1	4	8
			24+47 to 25+50		Type 1	4	6
	Talbert Ave	widen road and approach fill	17+80 to 21+71	SB, Left	Type 1	4	14
			27+88 to 35+30		Type 1	6	10
	Brookhurst St	widen road and approach fill	14+00 to 16+50	NB, Right	Type 5	4	8
			31+30 to 33+50		Type 5	4	8
			33+30 to 33+70	SB, Left	Type 5	4	4
	Slater Ave	widen road and approach fill	20+70 to 22+56	NB, Left	Type 1	4	14
			27+40 to 31+60		Type 1	4	24
	Bushard St	widen road and approach fill	21+20 to 22+09	SB, Left	Type 1	4	4
			27+01 to 33+00		Type 1	4	6
			32+10 To 33+00		Type 5	4	4
	Warner Ave	widen road and approach fill	115+74 to 118+90	SB, Right	Type 1	4	16
	Magnolia St	widen road and approach fill	103+21 to 111+31	NB, Right	Type 1	4	4
			117+45 to 117+95		Type 1	4	12
			124+30 To 125+61		Type 1	4	4
			103+21 To 103+60	SB, Left	Type 1	4	4
	Newland St	widen road and approach fill	480+80 to 484+23	SB, Left	Type 1	4	20
			488+90 to 492+30		Type 1	4	16
	Edinger Ave	widen road and approach fill	182+70 to 186+03	NB, Left	Type 1	4	6
			191+57 to 192+50		Type 1	4	4
	McFadden Ave	widen road and approach fill	484+00 to 485+34	SB, Right	Type 5	4	4
			486+46 to 488+70		Type 5	4	4
			494+98 to 499+60		Type 1	4	10
			485+45 to 488+47	NB, Left	Type 1	4	14
			493+52 to 497+30		Type 1	4	18
	Bolsa Ave	widen road and approach fill	88+10 to 89+71	SB, Left	Type 1	4	14
	Goldenwest St	widen road and approach fill	102+10 to 102+80	NB, Right	Type 1	4	4
			113+50 To 115+50		Type 5	4	4
			100+85 to 102+80	SB, Left	Type 1	4	10
			111+30 to 113+39		Type 1	4	12
	Edwards St	widen road and approach fill	501+60 to 504+06	NB, Right	Type 1	6	12
			508+51 to 511+00		Type 1	4	16
	Westminster Ave	widen road and approach fill	95+25 to 97+10	SB, Right	Type 1	6	6
			98+50 to 99+35		Type 5	4	4
			85+60 to 88+08	NB, Left	Type 1	4	12
	Springdale St	widen road and approach fill	503+10 to 505+25	NB, Right	Type 1	4	18
			510+20 to 513+60		Type 1	4	22
			511+77 to 512+80	SB, Left	Type 1	4	6
	Bolsa Chica Rd	widen road and approach fill	26+60 to 34+82	NB, Right	Type 1	4	20

**TABLE 3
SUMMARY OF GROUNDWATER DATA**

Structure Name	Approximate Original Site Grades (USGS 7.5' Quads)	Approximate Existing Ground Elevation (ft)		Mapped Highest Historical Groundwater		Highest Groundwater Encountered in Borings				Recommended High Groundwater for Preliminary Design		
		At Freeway	At Crossing Roadway/Creek	Depth (ft) assume with respect to Original Site Grades	Elev. (ft) with respect to Original Site Grades	Elevation (ft)	Depth Below Freeway (ft)	Depth Below Crossing Roadway/Creek (ft)	Exploration Reference and Year	Elevation (feet)	Depth (feet)	Depth referenced to current grade at:
Soundwall No. 103	33	32	N/A	12	21	17	15	N/A	CT 1987	21	11	Freeway
Bristol Street OC	33	32	N/A	12	21	17	15	N/A	CT 1993	21	11	Freeway
Retaining Wall RW5011	33	32	N/A	12	21	19	13	N/A	CT 1999	21	11	Freeway
RW / SW No. 4980	33	32	N/A	12	21	18	14	N/A	CT 1998	21	11	Freeway
Soundwall No. 131	32	32	N/A	12	20	16	16	N/A	CT1986	20	12	Freeway
Soundwall No. 151	32	32	N/A	12	20	17	15	N/A	CT1986	20	12	Freeway
Retaining Wall RW5050	32	32	N/A	12	20	16	16	N/A	CT 1998	20	12	Freeway
73/405 Connector OC	30	31	55	12	18	18	13	37	CT 1965	18	13	Freeway
MSE Walls 108, 109	30	31	N/A	12	18	15	16	N/A	CT 1993	18	13	Freeway
Fairview Rd OC	30	34	58	18	12	18	16	40	CT 1964	18	16	Freeway
Soundwall No. 251	30	34	N/A	18	12	22	12	N/A	CT 1986	22	12	Freeway
Retaining Wall RW6150	30	34	N/A	18	12	15	19	N/A	CT 1998	15	19	Freeway
Retaining Wall RW5650	30	34	N/A	18	12	16	18	N/A	CT 1998	16	18	Freeway
Retaining Wall RW5770	30	34	N/A	18	12	15	19	N/A	CT 1998	15	19	Freeway
Retaining Wall RW5790	30	34	N/A	18	12	14	20	N/A	CT 1998	14	20	Freeway
Retaining Wall RW6310	30	34	N/A	18	12	12	22	N/A	CT 1998	12	22	Freeway
Retaining Wall RW6345	30	34	N/A	18	12	14	20	N/A	CT 1998	14	20	Freeway
Harbor Blvd UC	30	58	28	25	5	13	45	15	EMI 1998	13	15	Harbor Blvd
Harbor Blvd UC RW	30	58	N/A	25	5	3	55	N/A	CT 1995	5	53	Freeway
Retaining Wall RW6950	30	58	N/A	25	5	10	48	N/A	CT 1998	10	48	Freeway
Retaining Wall RW18	30	58	N/A	25	5	7	51	N/A	CT 1998	7	51	Freeway
Santa Ana River Bridge	27	51	22	5	22	25	26	-3	CT 1964	25	-3	SAR Channel
Ward St OC	23	30	49	5	18	15	15	34	CT 1992	18	12	Freeway
Talbert Ave OC	25	31	59	5	20	14	17	45	CT 1964	20	11	Freeway
Soundwall No. 319	25	31	N/A	5	20	16	15	N/A	CT 1986	20	11	Freeway
Soundwall No. 328	25	31	N/A	5	20	17	14	N/A	CT 1986	20	11	Freeway
Soundwall No. 374	26	32	N/A	5	21	19	13	N/A	CT 1986	21	11	Freeway
Brookhurst St OC	27	33	56	5	22	18	15	38	CT 1962	22	11	Freeway
Slater Ave OC	28	33	56	5	23	22	11	34	CT 1963	23	10	Freeway
Soundwall No. 375	28	33	N/A	5	23	21	12	N/A	CT 1986	23	10	Freeway
Bushard St OC	29	34	56	5	24	20	14	36	CT 1962	24	10	Freeway
Warner Ave OC	23	31	51	5	18	1	30	50	EMI 1996	18	13	Freeway
Magnolia St OC	28	36	56	5	23	17	19	39	CT 1963	23	13	Freeway
Heil Ave POC	28	36	-	5	23	18	18	N/A	CT 1962	23	13	Freeway
Newland St OC	25	31	52	5	20	18	13	34	CT 1992	20	11	Freeway
Edinger Ave OC	26	33	56	6	20	15	18	41	CT 1962	20	13	Freeway
Retaining Wall No. 74	26	33	N/A	6	20	15	18	N/A	CT 1962	20	13	Freeway
Beach Blvd. UC (SR-39)	27	52	30	6	21	15	37	15	CT 1959	21	9	Beach Blvd.
Mc Fadden Ave OC	26	33	56	5	21	8	25	48	CT 1959	21	12	Freeway
Bolsa OH	27	59	32	6	21	18	41	14	CT 1958	21	11	RR Tracks
Bolsa Ave OC	27	31	49	6	21	8	23	41	CT 1959	21	10	Freeway
Goldenwest St OC	28	32	52	7	21	21	11	31	CT 1959	21	11	Freeway
Navy OH	28	59	32	8	20	15	44	17	CT 1958	20	12	RR Tracks
Edward St OC	29	36	57	8	21	22	14	35	CT 1958	22	14	Freeway
Westminster Ave OC	29	33	52	9	20	20	13	32	CT 1959	20	13	Freeway
Springdale St OC	28	34	57	9	19	21	13	36	CT 1959	21	13	Freeway
Bolsa Chica Rd OC	23	30	52	15	8	16	14	36	GDC 2008	16	14	Freeway
Seal Beach Blvd. OC	12	16	31	19	-7	0	16	31	EMI 2008	0	16	Freeway
605/405 Separation OC	10	20	50	20	-10	-1	21	51	EMI 2008	-1	21	Freeway

NOTE: LOTB for walls where groundwater was not measured or reported were not included.



**TABLE 4
SEISMIC SUMMARY**

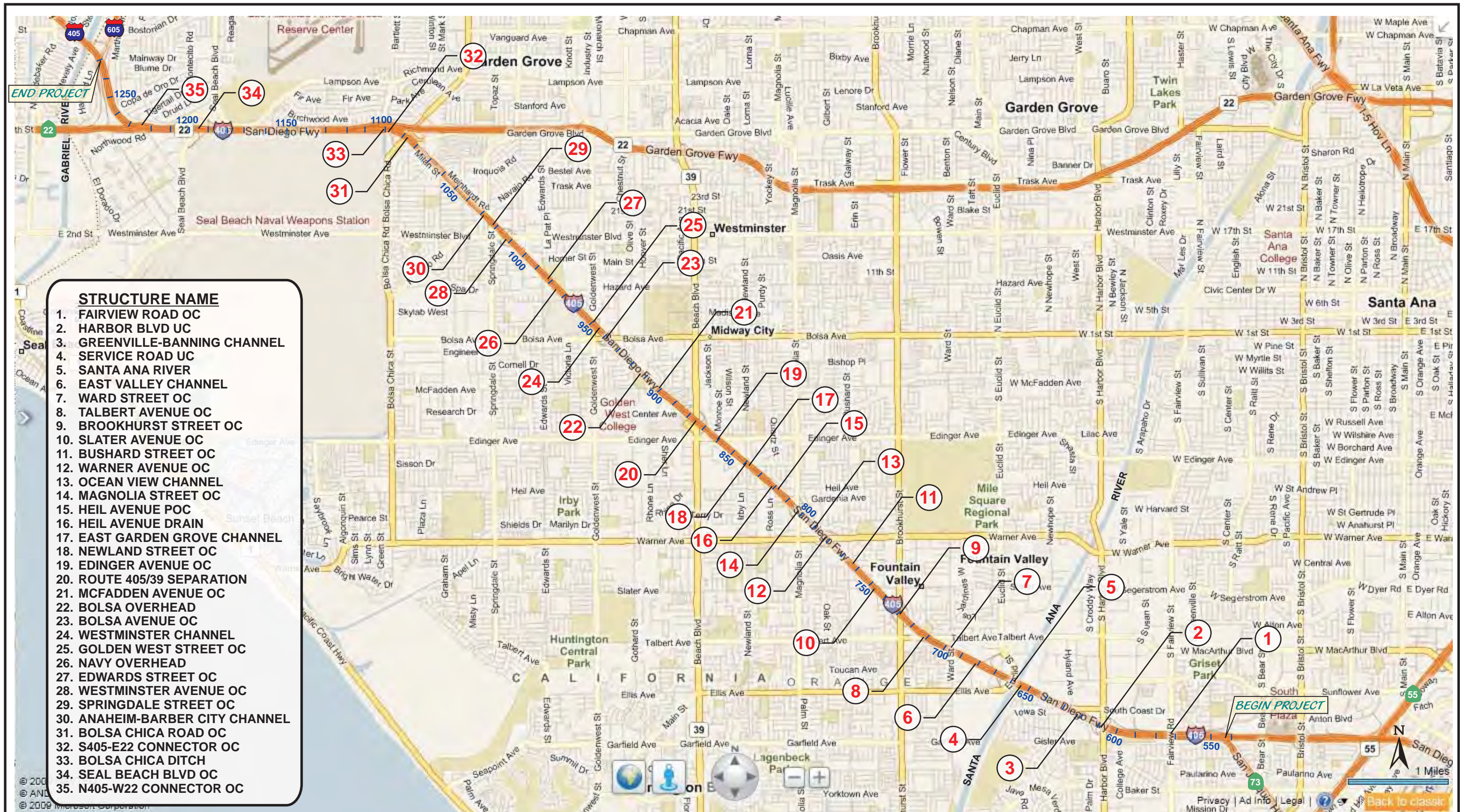
Bridge Location	Site Coordinates ¹		Distance, Rx (km) ²			Peak Ground Acceleration PGA ³	Fault(s) Controlling the PGA
	Latitude	Longitude	San Joaquin Hills [M=6.6] Blind Thrust	Newport Inglewood [M=7.5] Strike Slip	Compton-Los Alamitos [M=6.8] Blind Thrust		
73/405 Connector OC	33.6876	-117.8985	0.8	2.9	not controlling	0.60	San Joaquin Hills BT (Deterministic)
Fairview Rd OC	33.6879	-117.9078	0.9	2.5	not controlling	0.60	San Joaquin Hills BT (Deterministic)
Harbor Blvd UC	33.6892	-117.9194	0.9	2.1	not controlling	0.60	San Joaquin Hills BT (Deterministic)
Santa Ana River Bridge	33.6954	-117.9345	0.6	2.1	8.1	0.58	San Joaquin Hills BT (Deterministic)
Ward St OC	33.7000	-117.9456	0.9	2.2	8.1	0.54	San Joaquin Hills BT (Deterministic)
Talbert Ave OC	33.7017	-117.9494	1.0	2.2	8.1	0.53	San Joaquin Hills BT (Deterministic)
Brookhurst St OC	33.7054	-117.9543	1.1	2.5	7.2	0.52	San Joaquin Hills BT (Deterministic)
Slater Ave OC	33.7089	-117.9586	1.1	2.7	7.4	0.52	San Joaquin Hills BT (Deterministic)
Bushard St OC	33.7126	-117.9631	1.2	3.0	7.5	0.51	San Joaquin Hills BT / Compton Los Alamitos BT (Deterministic)
Warner Ave OC	33.7159	-117.9670	1.2	3.2	7.7	0.51	San Joaquin Hills BT / Compton Los Alamitos BT (Deterministic)
Magnolia St OC	33.7201	-117.9720	not controlling	3.6	7.9	0.51	Compton-Los Alamitos BT (Deterministic)
Heil Ave POC	33.7227	-117.9752	not controlling	3.7	8.0	0.51	Compton-Los Alamitos BT (Deterministic)
Newland St OC	33.7267	-117.9807	not controlling	4.0	8.1	0.51	Compton-Los Alamitos BT (Deterministic)

**TABLE 4
SEISMIC SUMMARY**


Bridge Location	Site Coordinates ¹		Distance, Rx (km) ²			Peak Ground Acceleration PGA ³	Fault(s) Controlling the PGA
	Latitude	Longitude	San Joaquin Hills [M=6.6] Blind Thrust	Newport Inglewood [M=7.5] Strike Slip	Compton-Los Alamitos [M=6.8] Blind Thrust		
Edinger Ave OC	33.7302	-117.9857	not controlling	4.2	8.2	0.51	Compton-Los Alamitos BT (Deterministic)
Beach Blvd. UC (SR-39)	33.7327	-117.9894	not controlling	4.3	8.3	0.51	Compton-Los Alamitos BT (Deterministic)
Mc Fadden Ave OC	33.7368	-117.9952	not controlling	4.5	8.4	0.52	Compton-Los Alamitos BT (Deterministic)
Bolsa OH	33.7392	-117.9983	not controlling	4.6	8.5	0.52	Compton-Los Alamitos BT (Deterministic)
Bolsa Ave OC	33.7446	-118.0047	not controlling	4.8	8.7	0.53	Compton-Los Alamitos BT (Deterministic)
Goldenwest St OC	33.7465	-118.0070	not controlling	4.8	8.8	0.53	Compton-Los Alamitos BT (Deterministic)
Navy OH	33.7510	-118.0124	not controlling	5.0	9.0	0.53	Compton-Los Alamitos BT (Deterministic)
Edward St OC	33.7533	-118.0151	not controlling	5.4	9.1	0.54	Compton-Los Alamitos BT (Deterministic)
Westminster Ave OC	33.7590	-118.0220	not controlling	5.5	9.3	0.54	Compton-Los Alamitos BT (Deterministic)
Springdale St OC	33.7613	-118.0246	not controlling	5.4	9.4	0.55	Compton-Los Alamitos BT (Deterministic)
Bolsa Chica Rd OC	33.7733	-118.0392	not controlling	5.3	9.9	0.56	Compton-Los Alamitos BT (Deterministic)
Seal Beach Blvd. OC	33.7744	-118.0750	not controlling	3.1	8.4	0.53	Compton-Los Alamitos BT (Deterministic)
605/405 Separation OC	33.7842	-118.0916	not controlling	2.9	8.6	0.52	Compton-Los Alamitos BT (Deterministic)

- Notes:** 1. Site Coordinates are from Google Earth.
2. Perpendicular distance from the site to the surface projection of top of fault, from ARS online
3. Assumes shear wave velocity in upper 100 feet (30 m) is $V_{S30}=270$ m/s

FIGURES



STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION	CONSULTANT FUNCTIONAL SUPERVISOR	CALCULATED-DESIGNED BY	REVISED BY		
ctb® Caltrans®		CHECKED BY	DATE	REVISED	

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
12,7	Ora, LA	22, 73, 405, 605	R0.5/R0.7, R0.7/R3.8 R27.2/R27.8, 9.3/24.2 6.0/1.2, 3.5/R1.6, R0.0/R1.2		
REGISTERED CIVIL ENGINEER			DATE		
PLANS APPROVAL DATE					
<p><i>THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.</i></p>					
PARSONS 2201 DUPONT DRIVE SUITE 200 IRVINE, CA 92612			ORANGE COUNTY TRANSPORTATION AUTHORITY 550 SOUTH MAIN STREET ORANGE, CA 92863		

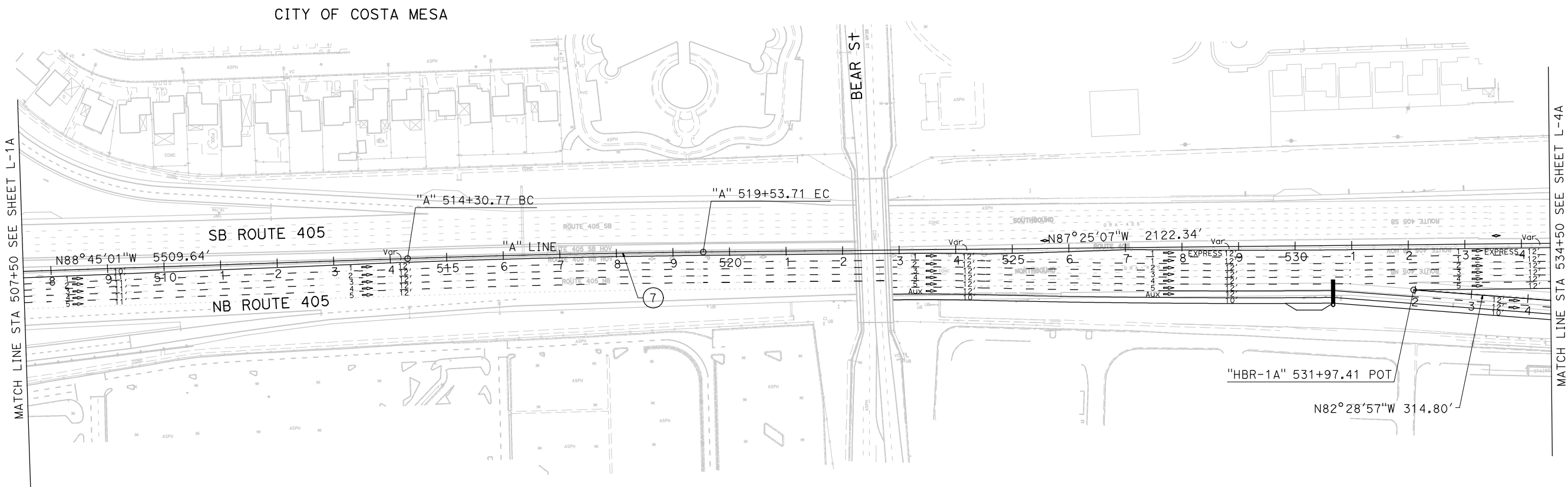
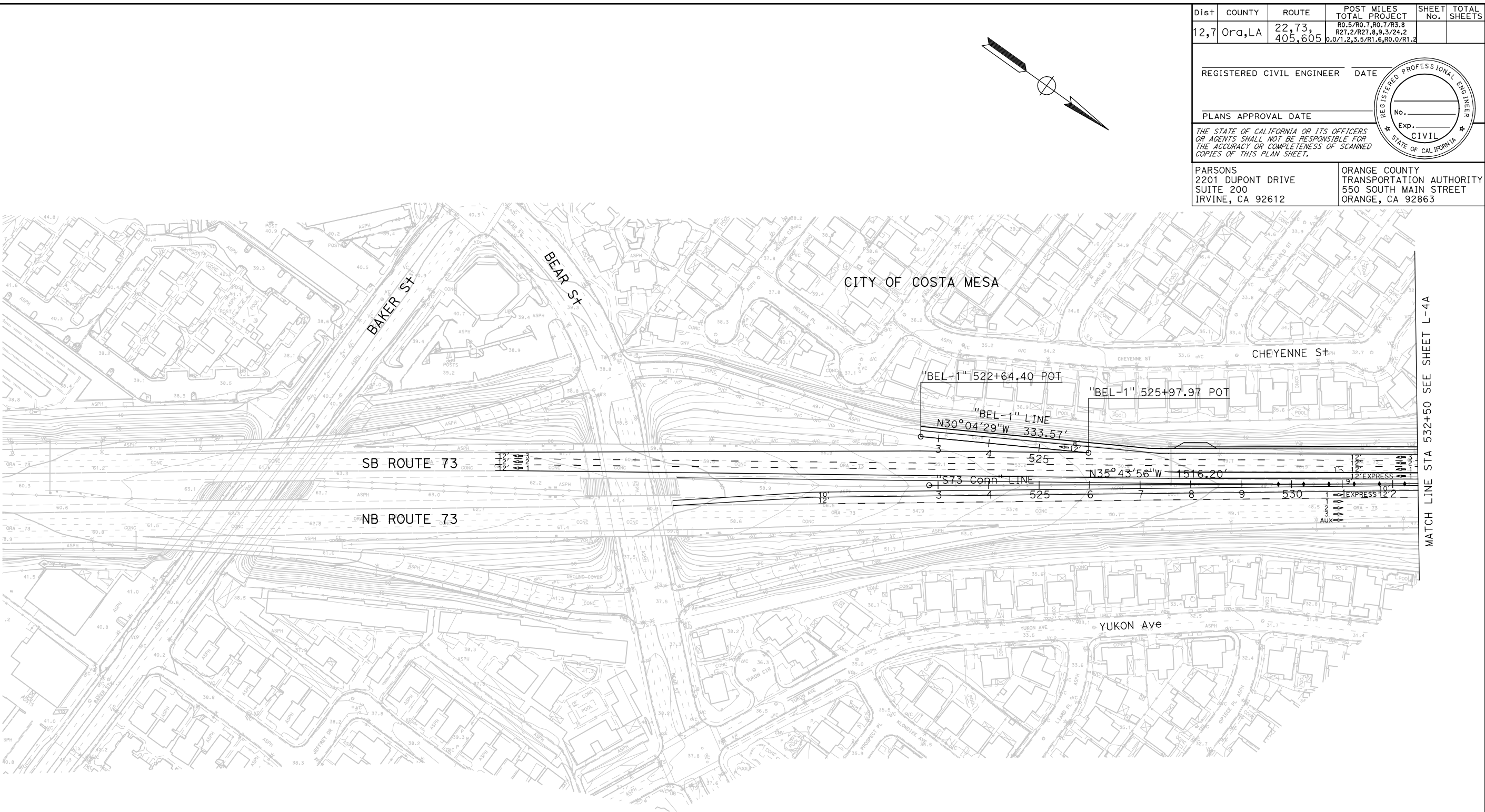


FIGURE 2-3

SCALE 1"=100' **L-2A**

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION	CONSULTANT FUNCTIONAL SUPERVISOR	CALCULATED- DESIGNED BY	REVISOR	DATE
CALTRANS	CHECKED BY	DESIGNED BY	REVISOR	DATE



Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
12,7	Oran,LA	22,73, 405,605	R0.5/R0.7,R0.7/R3.8 R21.2/R21.8,R3.3/24.2 R0.0/1.2,3.3/R1.6,R0.0/R1.4		
REGISTERED CIVIL ENGINEER DATE					
PLANS APPROVAL DATE					
THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.					
PARSONS 2201 DUPONT DRIVE SUITE 200 IRVINE, CA 92612			ORANGE COUNTY TRANSPORTATION AUTHORITY 550 SOUTH MAIN STREET ORANGE, CA 92863		

FIGURE 2-4

ALTERNATIVE 3
LAYOUT

SCALE 1"=100' L-3A

X

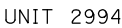
Subaru

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RELATIVE BORDER SCALE
IS IN INCHES




12000001800

No.	R	Δ	T	L
(42)	4250.00'	9°01'42"	335.54'	669.68'
(43)	20000.00'	0°09'32"	27.75'	55.50'
(44)	3041.00'	3°08'59"	83.61'	167.17'
(45)	20308.30'	0°50'47"	150.03'	300.05'
(50)	1400.00'	8°49'33"	108.04'	215.66'
(51)	12563.00'	1°20'11"	146.51'	293.01'
(62)	3500.00'	7°21'39"	225.13'	449.64'
(63)	1000.00'	10°58'31"	96.07'	191.55'
(64)	1400.00'	5°59'43"	73.31'	146.49'
(65)	3251.00'	7°11'05"	204.10'	407.67'
(66)	19982.00'	0°51'38"	150.05'	300.09'
(67)	4274.00'	3°37'10"	135.04'	270.00'
(68)	1400.00'	4°12'59"	51.54'	103.02'
(69)	20000.00'	2°01'30"	353.46'	706.85'
(70)	6102.50'	1°16'47"	68.15'	136.30'

No.	R	Δ	T	L
(8)	14090.00'	1°38'13"	201.29'	402.55'
(9)	14090.00'	1°38'13"	201.29'	402.55'
(10)	20200.00'	1°44'35"	307.27'	614.50'
(11)	20200.00'	1°57'22"	344.86'	689.66'
(25)	3524.00'	2°14'38"	69.01'	138.01'
(26)	210.00'	70°54'27"	149.54'	259.89'
(30)	1200.00'	51°41'11"	581.22'	1082.52'
(33)	1830.00'	2°31'07"	40.23'	80.44'
(34)	886.00'	50°32'27"	418.25'	781.54'
(35)	20000.00'	0°47'50"	139.13'	278.26'
(36)	3500.00'	2°17'43"	70.11'	140.21'
(37)	1806.00'	2°30'49"	39.62'	79.23'
(38)	862.00'	7°04'34"	53.30'	106.46'
(39)	450.00'	29°14'18"	117.38'	229.64'
(40)	1173.11'	12°03'28"	123.90'	246.88'
(41)	850.00'	7°27'15"	55.37'	110.58'



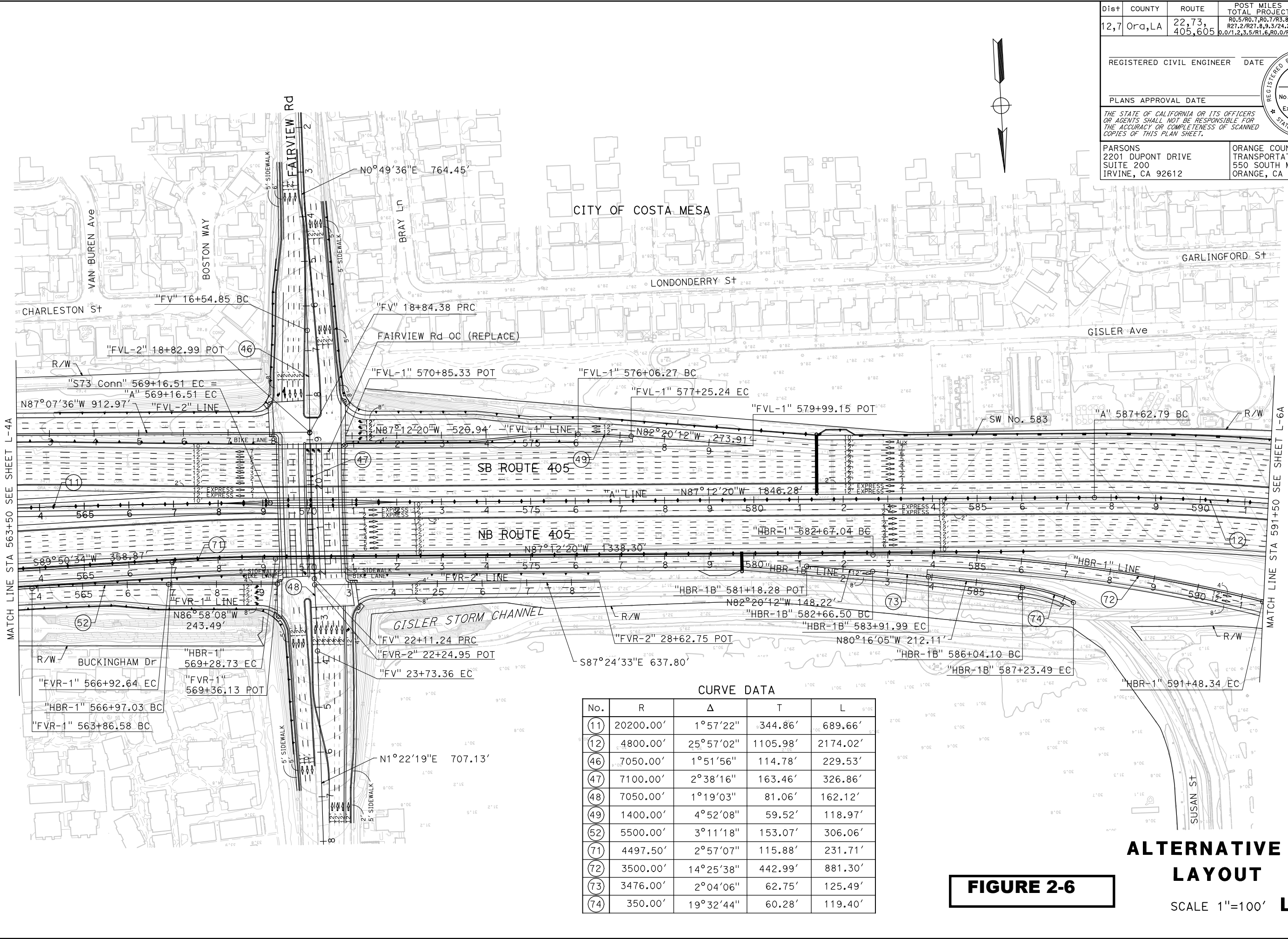
Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
12,7	Oran,LA	22,73, 405,605	RO.5/RO.7,RO.7/R3.8 R21.2/R21.8,9,3/24.2 0.0/1.2,3.5/R1.6,RO.0/R1.2		
REGISTERED CIVIL ENGINEER			DATE		
PLANS APPROVAL DATE					
<p><i>THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.</i></p>					
PARSONS 2201 DUPONT DRIVE SUITE 200 IRVINE, CA 92612			ORANGE COUNTY TRANSPORTATION AUTHORITY 550 SOUTH MAIN STREET ORANGE, CA 92863		



ALTERNATIVE 3 LAYOUT

SCALE 1"=100' **L-4A**

DATE PLOTTED => 8/15/2011	LAST REVISION
TIME PLOTTED => 2:49:49 PM	00-00-00



ALTERNATIVE 3
LAYOUT
SCALE 1"=100' **L-5A**

CURVE DATA				
No.	R	Δ	T	L
13	20000.00'	1°24'55"	247.03'	494.04'
14	20000.00'	0°45'13"	131.52'	263.04'
78	800.00'	25°54'40"	184.04'	361.79'
79	4500.00'	3°53'57"	153.18'	306.24'
80	3000.00'	3°11'29"	83.57'	167.10'

Dist

COUNTY

ROUTE

POST MILES TOTAL PROJECT

SHEET No.

TOTAL SHEETS

12,7

Ora,LA

22,73,405,605

R0.5/R0.7,R0.7/R3.8
R27.2/R21.8,9.3/24.2
0.0/1.2,3.5/R1.6,R0.9/R1.4

REGISTERED CIVIL ENGINEER

DATE

PLANS APPROVAL DATE

THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.

PARSONS
2201 DUPONT DRIVE
SUITE 200
IRVINE, CA 92612

ORANGE COUNTY
TRANSPORTATION AUTHORITY
550 SOUTH MAIN STREET
ORANGE, CA 92863

REGISTERED PROFESSIONAL ENGINEER

No.

Exp.

CIVIL

STATE OF CALIFORNIA

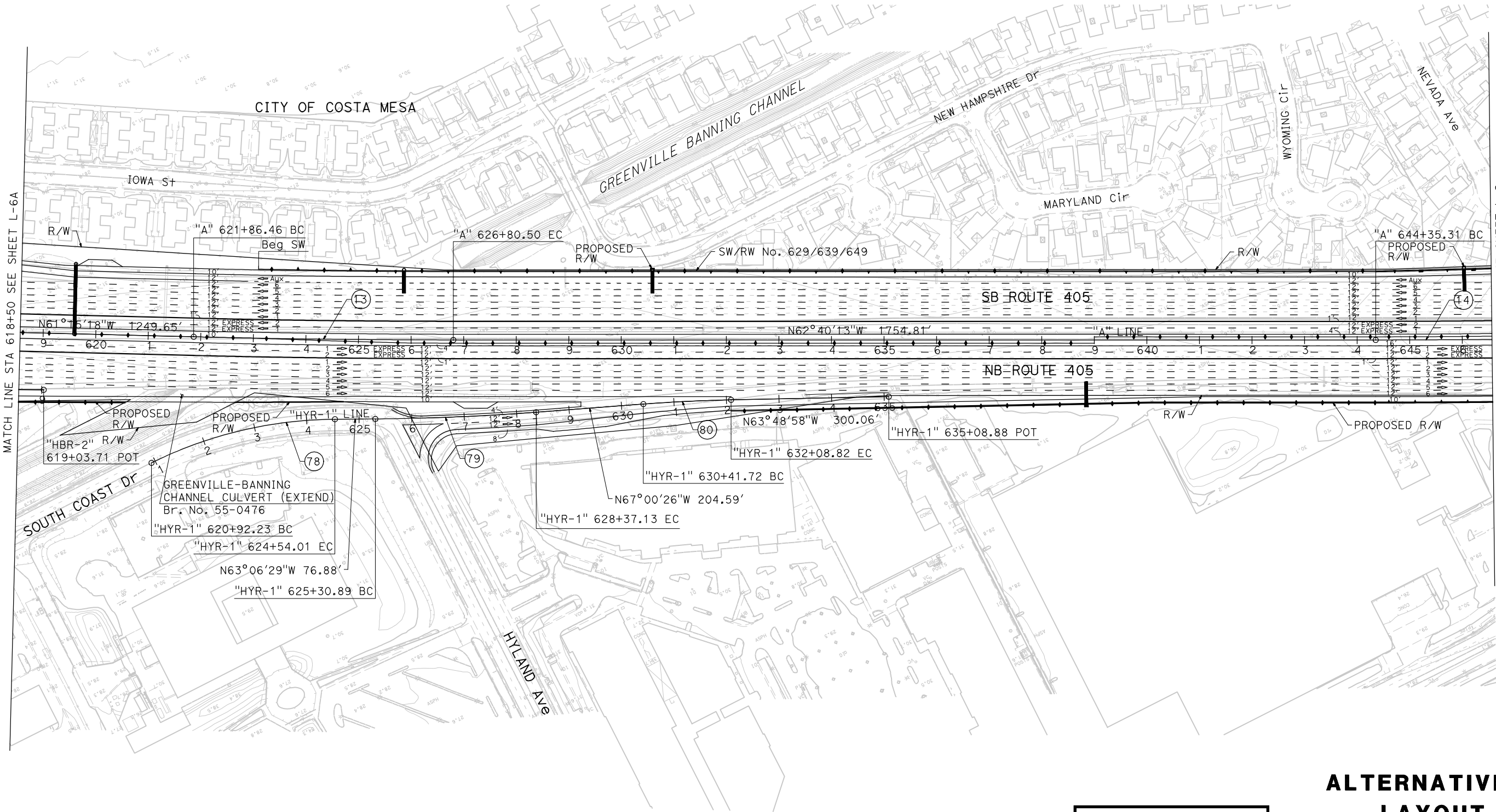


FIGURE 2-8

ALTERNATIVE 3
LAYOUT

SCALE 1"=100' L-1

Dist

COUNTY

ROUTE

POST MILES TOTAL PROJECT

SHEET No.

TOTAL SHEETS

12,7

Oran,LA

22,73,405,605

R0.5/R0.7,R0.7/R3.8
R21.2/R21.8,R3.3/24.2
R0.0/1.2,3.3/R1.6,R0.0/R1.4

REGISTERED CIVIL ENGINEER

DATE

PLANS APPROVAL DATE

THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.

PARSONS
2201 DUPONT DRIVE
SUITE 200
IRVINE, CA 92612

ORANGE COUNTY
TRANSPORTATION AUTHORITY
550 SOUTH MAIN STREET
ORANGE, CA 92863

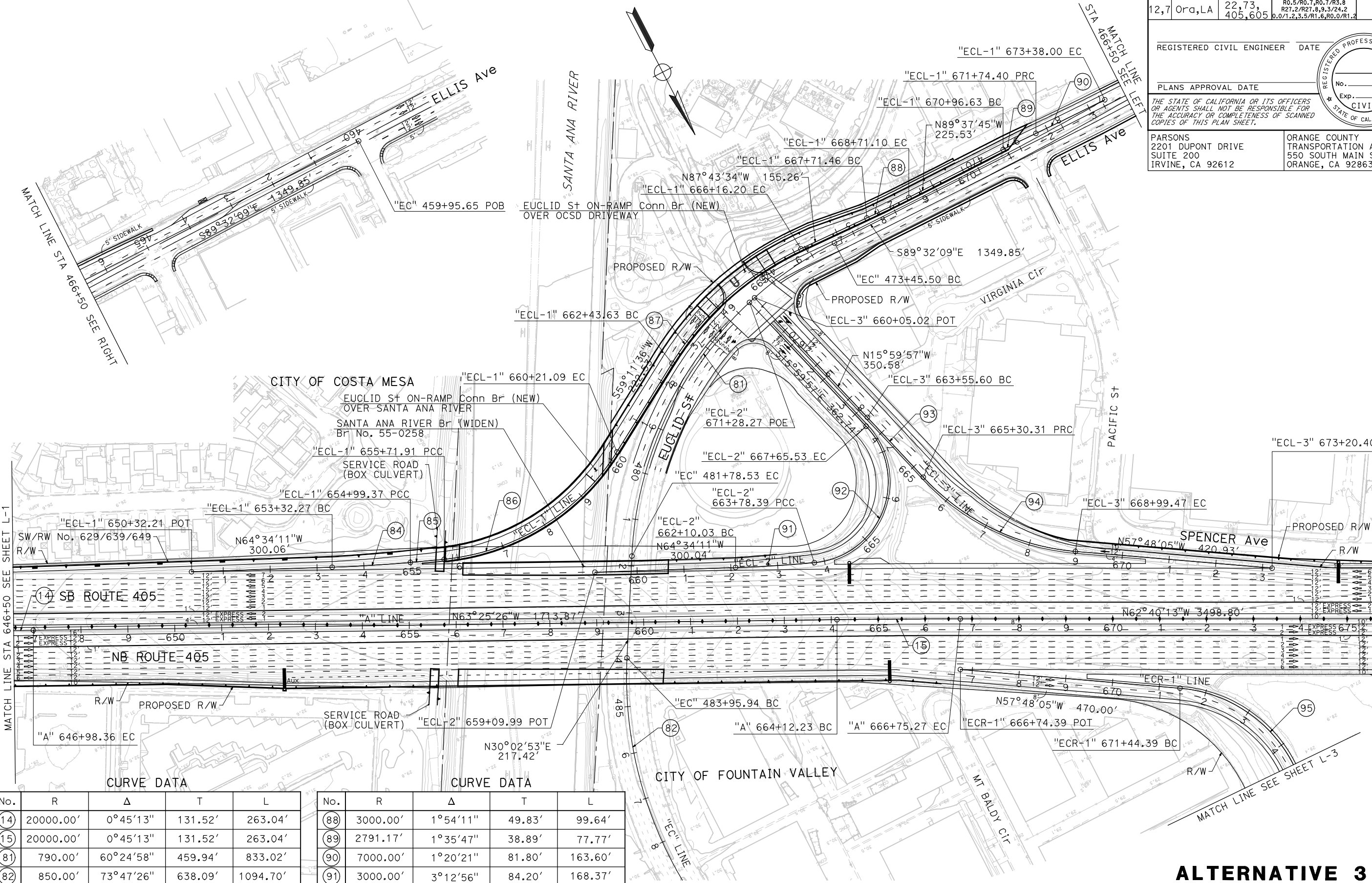
REGISTERED PROFESSIONAL ENGINEER

No.

Exp.

CIVIL

STATE OF CALIFORNIA



CURVE DATA				
No.	R	Δ	T	L
(14)	20000.00'	0°45'13"	131.52'	263.04'
(15)	20000.00'	0°45'13"	131.52'	263.04'
(81)	790.00'	60°24'58"	459.94'	833.02'
(82)	850.00'	73°47'26"	638.09'	1094.70'
(84)	3000.00'	3°11'29"	83.57'	167.10'
(85)	7954.00'	0°31'21"	36.27'	72.55'
(86)	490.00'	52°31'23"	241.76'	449.18'
(87)	645.30'	33°04'50"	191.64'	372.57'

CURVE DATA				
No.	R	Δ	T	L
(88)	3000.00'	1°54'11"	49.83'	99.64'
(89)	2791.17'	1°35'47"	38.89'	77.77'
(90)	7000.00'	1°20'21"	81.80'	163.60'
(91)	3000.00'	3°12'56"	84.20'	168.37'
(92)	173.00'	128°12'51"	356.39'	387.13'
(93)	20000.00'	0°30'02"	87.36'	174.71'
(94)	500.00'	42°18'10"	193.45'	369.16'
(95)	300.00'	104°32'27"	387.74'	547.38'

FIGURE 2-9

ALTERNATIVE 3
LAYOUT
SCALE 1"=100' L-2

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